In amended claim 1, Applicant claims:

> A method for detecting a threshold temperature in an integrated circuit comprising the steps of:
>
> generating a voltage reference that is substantially constant over a range of temperatures of said integrated circuit;
>
> receiving at least one programmable input that specifies a threshold temperature for said integrated circuit;
>
> generating a sensing voltage wherein said sensing voltage amplitude exhibits a substantially linear relationship with said temperature of said integrated circuit;
>
> generating a scale factor based on said programmable input;
>
> scaling said sensing voltage based on said scale factor to generate a comparison voltage such that when said integrated circuit attains said threshold temperature said comparison voltage is substantially equal to said voltage reference;
>
> comparing said reference voltage to said comparison voltage; and
>
> generating a signal when said comparison voltage exceeds said reference voltage to indicate said integrated circuit temperature attained said threshold temperature.

Amended claim 1 sets forth limitations directed toward detecting a threshold temperature in an integrated circuit. A voltage reference is generated that is substantially constant over a range of temperatures. The threshold temperature is specified through at least one programmable input. A sensing voltage, which indicates the temperature of the integrated circuit, is generated. Based on the programmable input, a comparison voltage is generated from scaling the sensing voltage to equal the voltage reference

when the integrated circuit attains the threshold temperature. In this way, the reference voltage is compared with the comparison voltage to detect whether the integrated circuit has attained the threshold voltage.

Giordano et al, U.S. Patent 5,359,236, discloses a thermal circuit that generates a turn-on signal that increases with increasing temperature of the circuit. The turn on signal is applied to a control device, wherein the threshold of the control device decreases with temperature. Specifically, the turn on signal is generated by sensing the difference between the base to emitter voltage of a bipolar transistor which is a function of temperature. This voltage is used in combination with the change in base-to-emitter voltage to produce an effective input signal to a bipolar transistor Q1 (Figure 4) (e.g. the effective signal is a combination of the absolute sum resulting from the positive temperature coefficient of the ΔV_{BE} signal and the negative temperature coefficient of the V_{BE} of Q1). (Column 5, lines 33 - 36).

Giordano et al discloses the use of this thermally compensated circuit to shut down power. Specifically, Figure 4 of Giordano et al discloses the collector of the Q1 transistor coupled to a node 30, which is the input to a flip-flop 40. In operation, as the temperature increases to critical value, Q1 begins to conduct current. The conduction of current through Q1 is accelerated due to the effective combination of the positive temperature coefficient of the ΔV_{BE} signal and the negative temperature coefficient of the V_{BE}. Therefore, Q1 sinks current to drive the node 30 to a nearly ground potential resulting in the setting of the flip-flop 40.

Giordano et al does not render the claims of the application obvious. Giordano et al does not disclose detecting a threshold voltage based on a programmable input as claimed in the present application. Instead, the generation of the shutdown signal from the flip-flop 40 is based on attaining a critical temperature. The critical temperature is based on fixed parameters of the circuit, and is not programmable. Furthermore, Giordano et al does not disclose:

> generating a scale factor based on said programmable input;
>
> scaling said sensing voltage based on said scale factor to generate a comparison voltage such that when said integrated circuit attains said threshold temperature said comparison voltage is substantially equal to said voltage reference;
>
> comparing said reference voltage to said comparison voltage; and
>
> generating a signal when said comparison voltage exceeds said reference voltage to indicate said integrated circuit temperature attained said threshold temperature.

In order to detect a fixed critical temperature, Giordano et al. discloses compensating Q1 for the increase in temperature to dissipate the voltage at node 30 as described above. Therefore, Giordano et al does not render the claims of the application obvious because Giordano et al does not disclose the limitations for detecting a threshold voltage as claimed in amended claim 1.

Nelson, U.S. Patent 4,7898,819, discloses a Brokaw Cell band-gap reference circuit with breakpoint compensation and thermal limit. In general, the Brokaw Cell band-gap reference circuit provides a constant voltage output over a range of temperatures. The Brokaw Cell band-gap

reference circuit operates such that the negative temperature of a base-emitter junction of a bipolar transistor opposes the positive temperature coefficient of a voltage difference ΔV_{BE}. The negative temperature and the positive temperature coefficient cancel each other out when the output voltage is approximately the bandgap voltage of silicon (e.g. 1.2 volts). (Column 3, lines 48 - 58) However, the circuit does not operate properly over a range of temperatures because the negative temperature of a base-emitter junction of the bipolar transistor and the positive temperature coefficient of a voltage difference ΔV_{BE} are not liner over a range of temperatures. The non linearity of the temperature coefficients are disclosed in Figure 2.

Nelson discloses utilizing breakpoint compensation in the Brokaw Cell band-gap reference circuit to minimize the non linear properties of the positive and negative temperature coefficients. In general, the use of breakpoint compensation manipulates the positive and negative temperature coefficients such that the Brokaw Cell band-gap reference circuit exhibits a more negative temperature coefficient in a lower temperature range and a more positive temperature coefficient in an upper temperature range. The effect of the breakpoint compensation is illustrated in Figure 3. Nelson also discloses a thermal breakdown circuit to shut off the power if the temperature of the circuit increases above 150 degrees C.

As discussed above, the purpose of the modified Brokaw Cell band-gap reference circuit, as disclosed in Nelson, is to provide a constant voltage output over a range of temperatures. In contrast, the present application claims detecting a threshold temperature, specified by at least one programmable input, in an integrated circuit. Applicant respectfully contends

that a reference circuit with breakpoint compensation is completely different than detecting a threshold temperature in an integrated circuit that is specified by at least one programmable input. Nelson does disclose a thermal limit circuit. (Column 6, line 46 - column 7 - line 27). However, the thermal limit circuit, does not operate in accordance with a programmable input, but is fixed (e.g. based on the temperature coefficient of transistor 452). Therefore, clearly, Nelson does not teach toward nor disclose the claimed limitations for detecting a threshold temperature in an integrated circuit.

The Examiner noted that Nelson discloses generating a scaling factor to obtain an output voltage with nominal temperature dependence. However, Applicant claims scaling the sensing voltage, based on the programmable input, to generate the comparison voltage, thereby permitting direct comparison with the reference voltage. The scaling in Applicant's claimed invention permits detecting variable threshold temperatures. In addition, the scaling of the sensing voltage for comparison with the reference voltage is not taught in the "CMOS Analog Circuit Design" reference cited by the Examiner.

Invitation for a telephone interview

The Examiner is invited to call the undersigned at 408-720-8598 if there remains any issue with allowance of this case.

Charge our Deposit Account

Please charge any shortage to our Deposit Account No. 02-2666.

CONCLUSION:

In view of the foregoing, Applicants submit that the amended claims are in condition for allowance. Withdrawal of the Examiner's objections and allowance of the claims is respectfully requested.

Respectfully submitted,
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

Dated: July 3, 1995

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I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class mail, in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on:
July 3, 1995

John C. Stattler — 7/3/95
John C. Stattler — *Date*